Title: If Humpty Only Knew

Brief Overview:

This learning unit involves four activities related to the real-life, open-ended decision-making associated with the renovation of a community park. Students will gather, organize, analyze, and interpret data, simulate possible outcomes, consider economic and safety factors, and use problem solving and logical reasoning to develop individual sets of plans for renovating Stats Park.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
  Students will demonstrate the ability to solve problems based on a variety of variables and potential outcomes related to the development of park renovation plans.

- **Mathematics as Communication**
  Students will use oral, written, and graphic methods to make decisions and to justify conclusions. They will incorporate the language of statistics and probability throughout the activity.

- **Mathematics as Reasoning**
  Students will use logical reasoning as they gather data, graph information, analyze the results, and interpret how the data will affect the renovations and park planning. They will gather and organize evidence and construct logical arguments.

- **Mathematical Connections**
  Students will make connections between this lesson and the social studies (map skills, community study, science (conducting an experiment, properties of matter), and language arts (speaking, listening, reading, writing) curriculum, within a real-world context.

- **Number Sense and Numeration**
  Students will demonstrate their ability to characterize and utilize number relationships.

- **Concepts of Whole Number Operations**
  Students will demonstrate skills in addition, subtraction, multiplication, division, and explain the effects of operations on numbers.

- **Geometry and Measurement**
  Students will demonstrate skills in the use of standard units. Students will demonstrate skills in area, parameter, and spatial arrangement.

- **Statistics**
  Students will demonstrate skills in data collection, organization, analysis, and interpretation in a variety of formats.

- **Probability**
  Students will demonstrate the ability to predict and to compare and evaluate predictions.

Grade/Level:

Third through fifth grades

Duration of Time:

This collection of interrelated activities will take approximately four class sessions.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Statistics and probability
- Place value through the ten-thousands place
- Computational skills
- Measurement by standard units

Objectives:

Students will:

- gather, organize, analyze, and interpret data in a variety of formats.
- construct and interpret probability scales.
- use language related to probability and statistics.
- construct and interpret double bar graphs.
- compute numeric values.
- use logical reasoning to formulate opinions.
- record and characterize important information.
- use number sense to find relationships between numbers.
- write for the purposes of informing and persuading.
- use a scoring rubric.

Materials/Resources/Printed Materials:

- Resource Sheets 1-8
- Paper for graphing, tape, markers
- Note cards (index or other)
- Approximately four dozen eggs
- Five boxes (canned soda case containers work well)
- Gravel, wood chips, grass, sand, special foam (Each of these materials is placed in a separate box. You need enough to provide two inches of depth, and special foam is an option. We also suggest carpet padding, shredded tires, or polyfill.)

Development/Procedures:

ACTIVITY 1:

The teacher presents the students with the following vignette:

> The County Council has decided to fund the renovation of Stats Park, which is located just behind our school. The County Council is accepting proposals of plans. Safety is the major concern and decisions to replace or relocate the swings, slide, climbing bars, see-saw, and/or merry-go-round are to be addressed. The budget is limited to $10,000.00.

The teacher guides students through a discussion of why parks need renovation, why safety is a major issue, how decisions could be made, and what other options could be available.

The teacher distributes Resource 1. Students read and discuss facts and proposal requirements.

Students investigate the map of Stats Park (Resource 2). In small groups, students discuss the likelihood of injury using background knowledge (experience on equipment) and the current placement of equipment in the park (as indicated on the map).

Students construct individual probability plots related to the outcome of possible injury (use Resource 3). The teacher should encourage students to use mathematical language such as highly likely, unlikely, certain, possible, impossible, slight chance, great chance, etc.

Invite each student to combine her/his set of probability plots into one. Encourage students to use accurate and creative ways of indicating equipment types on the inclusive probability plot. Allow students to share and compare completed probability plots with classmates.

ACTIVITY 2:

Use Resource 4 to introduce statistics gathered by Dr. Data related to the injuries that occurred at Stats Park. Invite students to explain the relationship between values and the operations used to fill in the missing numbers.

Provide students with paper for graphing, reminding them that bar graphs are not always vertically oriented. Students should be encouraged to work in small groups to cut and tape paper to form the bars for the double bar graph. Help students focus on how the aspects of the table will be displayed. [Point of differentiation: Some students may need to construct two separate graphs (number of injuries and number of non-injuries) as an initial step, while other students may need to focus only on the total usage, forming single bar graphs.]

After students have constructed the double bar graphs, invite them to analyze and interpret the information in small groups, noting how the visual format is a beneficial tool. Encourage students to consult the Map of Stats Park (Resource 2) as they review the double bar graphs.

Students should now begin to consider possible park renovations. Student reasoning and higher level thinking may be further promoted through the considering possible decision related to:

Replacing or retaining certain equipment
Purchasing new or multiple equipment
Relocating equipment

Have students record conclusions and rationales related to each type of equipment on individual note cards. Recording pros, cons, and related reasons is one possibility.

Invite students to create new probability plots in light of the Stats on Stats Park, using the template in Resource 3 or individually created versions. [Point of differentiation: Some students can work with ratios and percentages to uncover the probability of injury and non-injury.]

ACTIVITY 3:

Allow students to recall various materials that they have observed as ground cover at the parks that they have visited.

Ask students to discuss possible factors involved in deciding which materials should be used.

Prepare and distribute materials to conduct an experiment simulating the safety of particular types of ground covering materials. Each group needs to have a box filled with two inches of one of the substances (gravel, grass, sand, wood chip, or special foam). A five foot drop mark needs to be made on the wall or by a string hanging from the ceiling.

Students take turns dropping the egg (or its replacement) five feet into the box filled with a ground cover replica, observing the outcome (cracked or undamaged). Using Resource 5, students indicate a cracked egg result in red and record in a clockwise manner on the circle graph template. Undamaged egg results are indicated in black and recorded in a counterclockwise sequence. Each group member will complete a circle graph of the group results.

Instruct students to cut out the circle graphs they have completed. Collect one circle graph from each group and gather the students together to discuss the results and analyze the collected data. Encourage the students to share any conclusions they may develop related to the ground cover options based on the results of the egg drop simulation. At this point, there are two instructional options for further analysis and interpretation. Please choose an option based on the needs and abilities of your students.

1. Redistribute the circle graphs so that each small group has a set of data for each type of ground cover. Students may then create a visual display of the experiment data (five circle graphs) and include titles, labels, and an written analysis of conclusions.

2. Redistribute the circle graphs so that each small group has a set of data for each type of ground cover. Students then note the markings (smaller circles) and the labels on the pie graph and cut each circle so that it represents a different ground cover. Once all circles have been modified, order circles from smallest to largest and put them in a pile. The circle graphs are then connected with one brass fastener through the center of each circle. This will create a wheel including all five circle graphs which may be rotated to assist in comparing and contrasting the cracked and undamaged eggs for each type of ground cover. Students may then create a visual display of the experiment data (five circle graphs) and include titles, labels, and an written analysis of conclusions.

ACTIVITY 4:

Students will now compile all of the data and conclusions they have gathered related to Stats Park. Each student will use this information to compose a letter of the proposed plans to be submitted to the County Council. Distribute Resource 6 to the students. They will use this checklist in writing their proposal letter. The checklist outlines those components needed for a complete proposal letter. The components include an emphasis on justification of all decisions through supportive data, graphs, diagrams, or explanation of reasoning.

Performance Assessment:

Students can be assessed at numerous points during this collection of interrelated activities. Informal methods include observation and listening. Formal methods include evaluating products and interpretive information. The tools provided, a checklist for the task (Resource 7) and a rubric (Resource 8) to construct and assess the culminating activity (writing up the proposal of plans for park renovation). We encourage you to use the rubric in four ways; (1) student self-assessment; (2) teacher assessment; (3) peer assessment; (4) mock County Council assessment (which could be another class, a group of parents, or a corporation that is in a business partnership with your school). [For peer and mock Council review, anonymous proposal submissions may work best. Students could use code names or the teacher could develop a system for concealing names.]

Extension/Follow Up:

There are numerous other avenues to explore related to this renovation task. Students could:

- investigate other playground equipment.
- use the data gathered by Dr. Data to construct a table that depicts a month of park activity.
- discuss how the data may not have been the same if it was gathered in February.
- change the variables in the simulation experiment (use four or more inches of ground cover, vary the drop height, change temperature of eggs, and numerous other possibilities).

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Park Renovation Project

The county council has decided to offer funds to renovate the community park. They have distributed the following notice to various community members who may be interested in submitting a proposal of plans for improvement.

Stats Park Renovation Project

Facts:

1. **The ten-year old park needs renovating.**
2. **Safety is a main priority in renovation decisions.**
3. **The budget is limited to $10,000 for materials.**

Proposal Requirements:

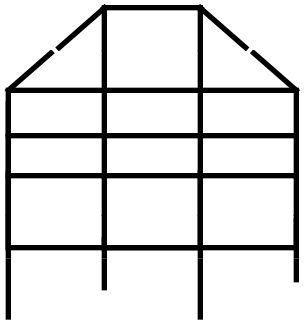
Proposed plans must include the following components:

1. ***Choice of play equipment to be in park***
2. ***Map of suggested layout of equipment***
3. ***Decision regarding ground cover under equipment***
4. ***Budget proposal for the distribution of funds***
5. ***Letter explaining and justifying your proposed plans***

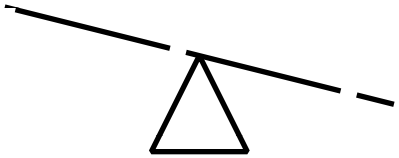
Each member of our class will submit a proposal of plans. We will spend the next several days investigating the renovation ideas, organizing, analyzing, and interpreting data related to the park renovation project.

Resource 2

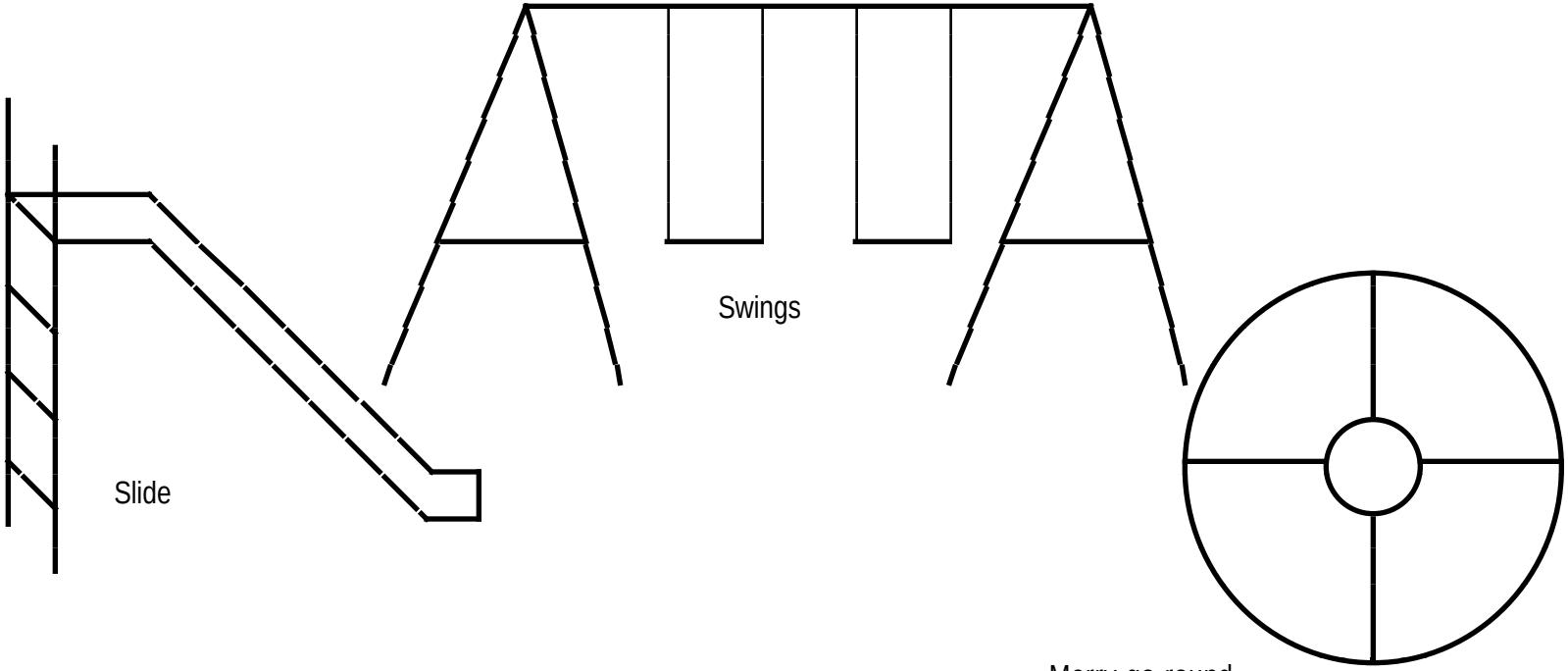
Map of Stats Park



Climbing Bars



See-saw



Slide

Swings

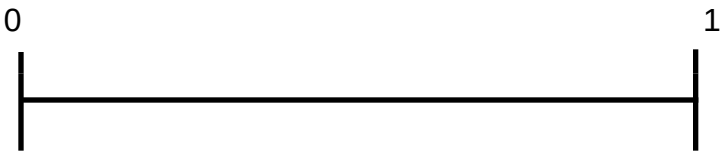
Merry-go-round

Resource 3

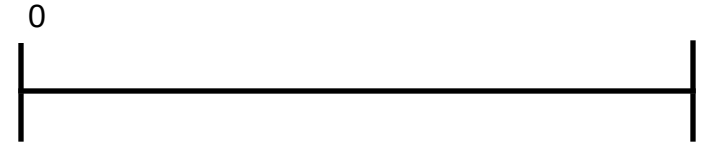
Probability Scales of the Outcome of Injury

Impossible Outcome — Certain Outcome

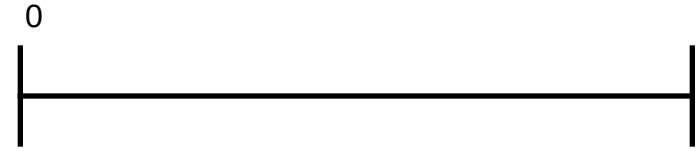
Swings



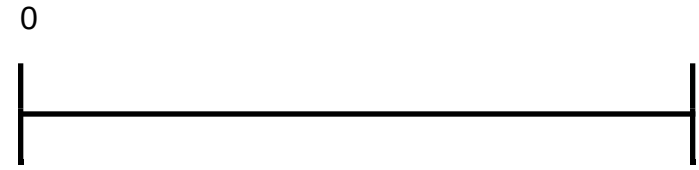
Slide



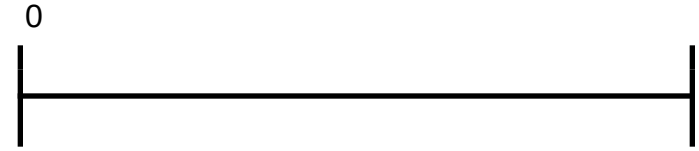
See-saw



Climbing bars



Merry-go-round



Dr. Data observed park usage and incidences of injury the first full week of June. The table below is a summary of the observations.
(Note: Dr. Data intentionally left out four values because he knew you could figure them out.)

Stats on Stats Park

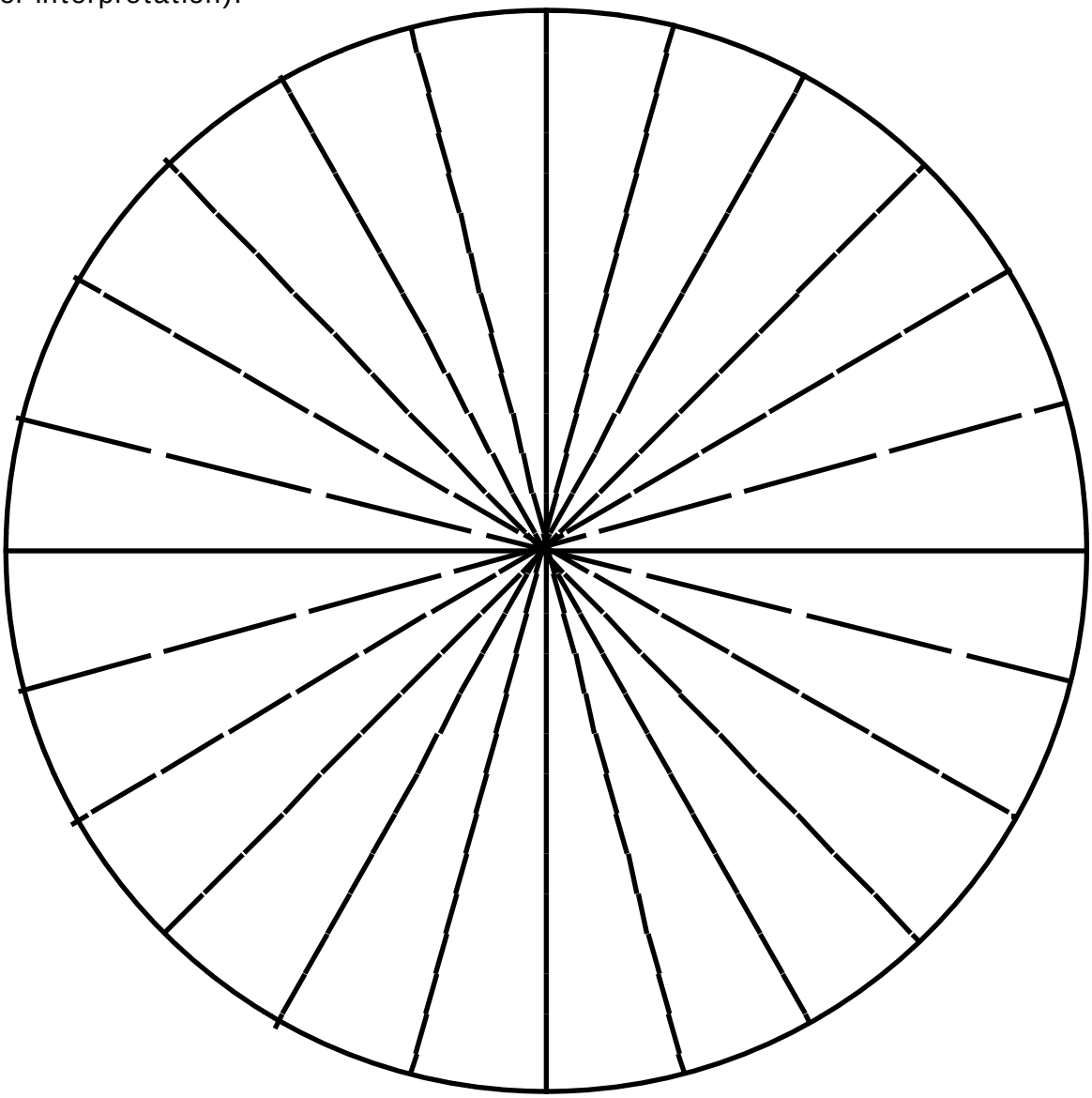
	Swings	Slide	See-saw	Climbing Bars	Merry go-round
Equipment usage resulting in injury	**11**	**8**	**3**		**9**
Equipment usage <u>not</u> resulting in injury	**103**		**81**	**134**	
Total Usage	**114**	**32**		**138**	**156**

Using the information gathered by Dr. Data, complete the table and construct a double bar graph to display the number of injuries and non-injuries related to each piece of equipment. Remember to keep the scale constant, label each axis, code outcomes, and include a title.

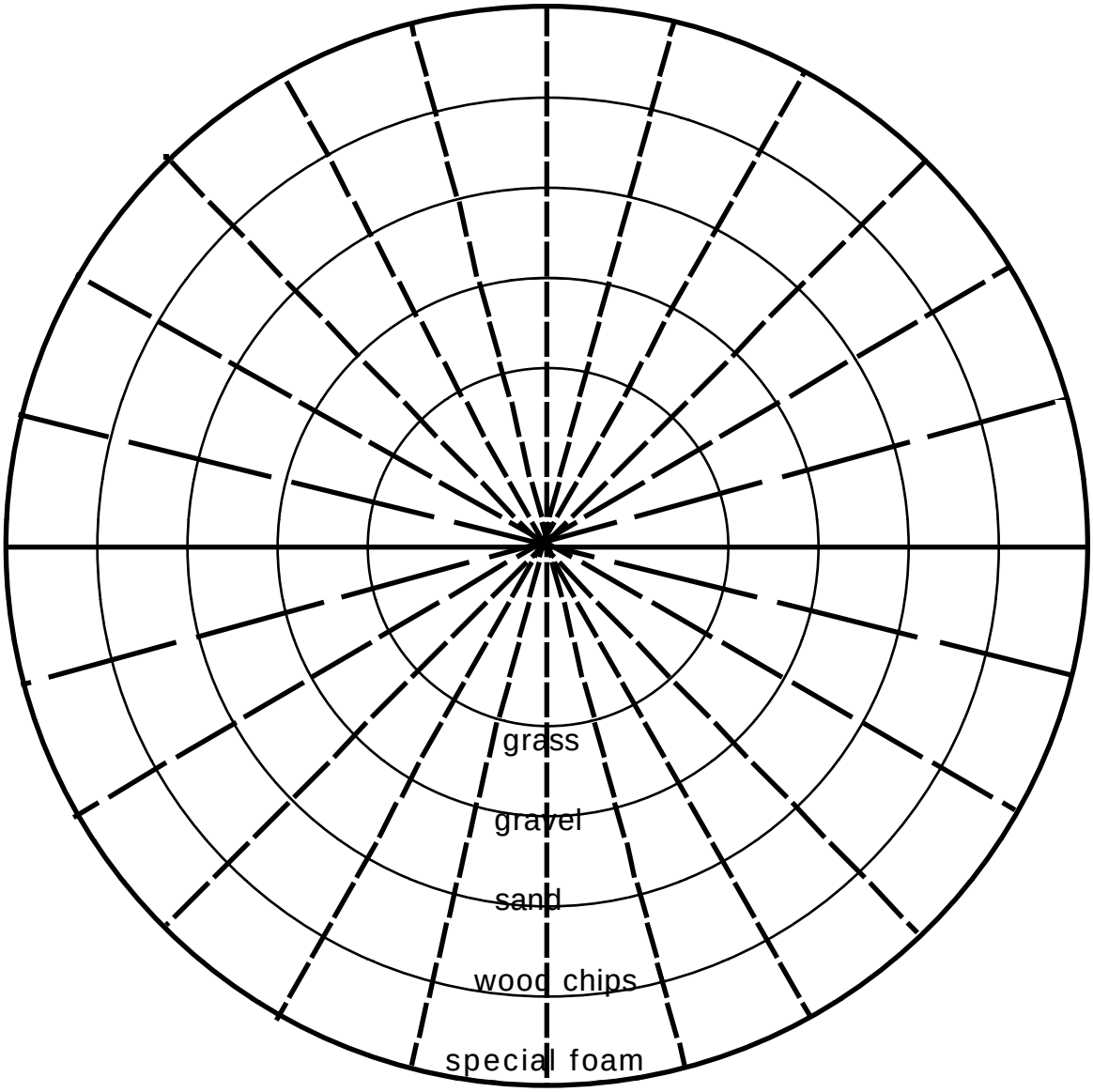
In your group, discuss the relationships between the two outcomes associated with each piece of equipment.

Resource 5a

Currently, Stats Park has wood chips under each piece of equipment. As you develop your renovation plans, you will consider other possible ground cover options. To help make your decision, you will be conducting an experiment to simulate the relative properties of grass, gravel, sand, wood chips, and special foam. In your small group, test the surface covering by dropping an egg from the five foot mark into the box containing the selected material, Record the results (cracked or undamaged) on the circle graph. The experiment should include twenty-four trials. Using the circle graph shell, record the results of each trial. When completing the circle graph, record the cracked egg count (red) in a clockwise direction and the undamaged egg count (black) in a counter-clockwise direction, (this will cluster like results which will simplify later interpretation).



Resource 5b (optional)



Materials Price List

Equipment	Replacement Cost	Relocation Cost
Swings	$1,406.00	$ 703.00
Slide	$2,480.00	$1,240.00
See-saw	$ 853.00	$ 426.50
Climbing Bars	$ 686.00	[ ] *
Merry-go-round	$2,237.00	[ ] *

*Note the relationship between the relocation cost and the replacement cost. Calculate the relocation cost for the other pieces of equipment.

Ground Cover Materials	Price
Gravel	$ 980.00
Sand	$1,800.00
Wood chips	$2,300.00
Special Foam	$3,640.00

Proposal Letter Checklist

☐ Choice of Equipment
* Decide which equipment will remain or be removed.
* Provide justification for your choices.

☐ Map of Park Layout
* Create a display of the desired arrangement of equipment for the park.
* Label the equipment names or include a key on your map.
* Provide justification for your choices.

☐ Ground Cover
* Make a recommendation for ground cover for the park.
* Justify your choice with the data collected from the experiment.

☐ Budget
* Construct a table to display the distribution of the funds ($10,000).
* Be sure your calculations are accurate.

Scoring Rubric

4 Letter containing grant proposal includes all four components: choice of equipment, may of layout, ground cover recommendation, and budget. Choices include strong and logical justification, supported by data, diagrams, graphs, of other facts.

3 Letter includes the four required components. Strong justification is present for at least one or two of the four components. The others may lack detail of contain faulty logic based on the supporting data.

2 Letter contains only two or three components with weak justification, or all four components are addressed with little or illogical reasoning.

1 Letter includes only two components with no justification.

0 Letter includes only one component and justification is absent.